THURSDAY, JANUARY 5, 1905.

MODERN OPTICAL METHODS.

Die Bilderzeugung in optischen Instrumenten, vom Standpunkte der geometrischen Optik. By the Scientific Staff of Carl Zeiss's Works. Edited by M. von Röhr. Pp. 588; with 133 woodcuts. (Berlin: Julius Springer, 1904.)

Grundzüge der Theorie der optischen Instrumente nach Abbe. By Dr. Siegfried Czapski. Second edition. Edited by Dr. O. Eppenstein, with the assistance of M. von Röhr. Pp. 490; with 176 woodcuts. (Leipzig: Johann Ambrosius Barth, 1904.)

THE old geometrical optics which we used to read at Cambridge was a delightful subject. It would have been a still more delightful subject had examiners set better questions on it. Probably no other branch of mathematics would lend itself so well to the kind of treatment which is now fortunately coming into fashion, viz. the use of graphical and experimental methods. If the German system of Lehr freiheit prevailed in this country I would rather teach geometrical optics to an elementary class than geometry adapted to modern requirements.

This elementary optics, however, bears about the same relation to the optics treated in the first of these books that Newton's deductions from Kepler's laws bear to the planetary theory. The analogy is the more complete in that both the optician and the astronomer have found it impossible to obtain an exact solution by direct methods, and they have therefore been led to employ the method of trial and error in order to obtain successive approximations giving the desired results to closer and closer degrees of accuracy. As Messrs. Czapsky and Siedentopf point out (p. 25), the exact determination of the forms of the refracting surfaces required to produce exact images subject to given conditions has never been effected, except in a few cases, such as the Cartesian oval, in which rays from one focus converge to a point in the other. We therefore take spherical surfaces, and by calculating the various kinds of aberration, show how they may be corrected. It is, however, interesting to learn that the theory of non-spherical surfaces has quite recently been put into practice in the Zeiss works for the first time in the construction of lenses other than large reflectors and refractors for telescopes. It has, in fact, been found possible to correct certain residual aberrations by applying finishing touches to the lenses giving them a slight deviation from sphericity.

The analogy between the problems of the optician and the astronomer is made still closer by observing how different specialists have confined their attention to particular kinds of aberration in the one case and of perturbation in the other, and have devised special methods for simplifying the calculation of the corresponding terms.

In his preface Dr. Czapski tells us that the present work owed its origin to the demand for a revised edition of his "Theorie der optischen Instrumente nach Abbe," published in 1893. Being unable to undertake the work himself, the idea suggested itself that a better purpose would be served by obtaining the collaboration of a number of joint authors, and that no better body of men could be found for the purpose than the scientific staff of the Zeiss firm.

The work has been divided among the seven joint authors as follows:—The first chapter, dealing with the fundamental principles of optics, including the laws of re raction, the principle of minimum path, and the characteristic function, is contributed by Drs. Czapski and Siedentopf; Drs. König and von Röhr contribute the second chapter, on formulæ of calculation, and the fifth, on spherical aberration, in which latter is contained a complete exposition of Abbe's method of invariants and its application to the determination of the ten corrections determined by the problem of Seidel. The chapters on chromatic aberration and on determination of optic systems according to the theory of aberrations (chapters vi., vii.) are contributed by Dr. König alone. "The Geometrical Theory of Images after E. Abbe" is the title of the third chapter, by Dr. Mandersleb. In the fourth chapter, by Dr. P. Culmann, on the realisation of optical images, we actually do find our old friend the formula

$$\frac{\mu}{v} - \frac{1}{u} = \frac{\mu - 1}{r},$$

in a position, however, of subsidiary importance. Dr. Löwe contributes a chapter on prisms, while Dr. von Röhr is responsible for the last two chapters, dealing with the breadths of pencils, penetration, brightness of images, and similar matters.

The second of these books is of a more elementary and practical character. It contains a general discussion of images formed by small pencils, and illustrated descriptions of the principal optical instruments. The corrections are discussed, but the discussions are less mathematical. The theory of conjugate foci receives fairly full treatment, and among the interesting features which we notice at a first glance, attention may be directed to the series of sections of a pencil of light on p. 24, and the figures of an object and its image on p. 40, where the object is an arrow in a plane through the axis of a lens, and is bisected by the focal plane of the lens.

This is the second edition of a book of which the first edition was written for Winkelmann's "Handbuch der Physik." Of matter new in this edition, Dr. Eppenstein contributes chapters on screens, on projection apparatus, and on the illumination of objects; chapters on vision, on photographic objectives, and on spectacles are contributed by Dr. M. von Röhr.

The perfection to which the manufacture of optical instruments has been brought by the Zeiss firm is well known, and it is also pretty generally realised that the results attained could not have been accomplished by an establishment run on purely business lines by "practical men" falsely so-called. The usual stock form in which the last named class of individual recommends his wares to the public is the stereotyped statement that "The materials used in the preparation of these goods are of the best quality obtainable."

The present books furnish abundant proof that this statement is particularly applicable to the Zeiss instruments in regard to the quality of those materials most essential for the production of good optical apparatus, viz. brains and knowledge of advanced mathematics.

G. H. BRYAN.

AMERICAN CYTOLOGY.

Fecundation in Plants. By David M. Mottier, Ph.D. Pp. viii+187. (Washington: Published by the Carnegie Institution, 1904.)

Contributions to the Knowledge of the Life-History of Pinus, with Special Reference to Sporogenesis, the Development of the Gametophytes and Fertilisation. By Margaret C. Ferguson, Ph. D. Pp. 153. (Washington: Published by the Washington Academy of Sciences, 1904.)

MR. MOTTIER'S "Fecundation in Plants" gives to those who are interested in cytology an account of the phenomena of fertilisation throughout the vegetable kingdom, written by one who has carried on investigations in several branches of the subject with success. His practical acquaintance with his subject confers even on his descriptions of the investigations of others a freshness which makes his work a pleasure to read. The first chapter is perhaps the most generally interesting. In it he gives an account of some of the vexed problems of karyology which are at present calling out so much controversy among cytologists. Among these problems may be mentioned the existence of centrosomes, the homology of centrosomes and blepharoplasts, the nature of synapsis, the significance of the sexual process, and the numerical reduction of chromosomes. The author's method of discussion is candid. He avoids being dogmatic in expressing his own views, although he criticises somewhat severely the observations of others. He holds that centrosomes and centrospheres do not occur in plants higher than the liverworts, and are, indeed, only well established in a few of the Thallophyta. It is remarkable that he does not allude to the possibility that the radiations at the poles of mitoses may be in part artefacts produced by the fixing agents. He considers Belajeff hasty in coming to the conclusion that the centrosome is the homologue of the blepharoplast; but he admits later on that certain "facts lend encouragement to the belief that centrosome and blepharoplast may be homologous structures." Mottier regards synapsis as due in a large measure to the action of reagents. He accepts Strasburger's theory of the numerical reduction of chromosomes as a good working hypothesis, and he holds now that there is no evidence for Weismann's "reduction" to be found in the mitoses of plants. His candid expression of doubt as to the persistent individuality of the chromosomes preserved through the successive mitoses—so often assumed, though almost involving a miraculous resurrection—is typical of his attitude of independence.

The succeeding chapters give an account of fertilisation in types taken from the various subdivisions of the vegetable kingdom. These descriptions are most useful in bringing together what is scattered sporadically through botanical literature into the compass of a short, well written book. The work is illustrated by blocks in the text, which show in a satisfactory manner the points to be brought out.

Miss Ferguson's memoir has a more limited scope, but this allows her to devote more space to her own researches, which have been very extensive in the cytology of the spore-production of conifers. It is quite remarkable to see how two cytologists, writing almost simultaneously, can hold so divergent views on fundamental subjects. While Mottier sees in the fusion of sexual nuclei the blending of two lines of descent, Miss Ferguson's researches lead her to believe that no fusion-nucleus, combining the paternal and maternal hereditary substances, is formed. Rather the processes of mitosis allow these to be kept apart during the life of the offspring, and the "reduction" or qualitative division occurring some time during the life-cycle secures that the gametes shall be "pure." It is evident that the later writer is concerned with the relation of mitosis to Mendel's views rather than to Weismann's hypothesis. With regard to synapsis, Miss Ferguson believes it to be a normal stage in heterotypic mitosis. Another point of difference is the mode of origin of the double chromosomes of heterotypic mitosis. Miss Ferguson finds confirmation in her preparations for the view (first published by the writer of this review in 1896, *Proc.* Roy. Irish Acad.) that the two arms of the chromosomes are approximated pieces of the nuclear thread, and do not arise by longitudinal cleavage as Mottier believes. This interpretation seems to be gaining ground, and the Louvain school, once so much opposed to it, has recently accepted it, putting the folding back, however, to the synaptic stage. The reviewer's investigations seem to suggest the possibility that two distinct foldings take place, one during synapsis and another between that stage and the differentiation of the chromosomes. Whatever views are held on these disputed matters, all cytologists are indebted to the author for her beautiful drawings, which are reproduced in a series of twenty-four plates.

There is no doubt that the publication of these two memoirs, the one by the Carnegie Institution and the other by the Washington Academy, will be of much service to those engaged in cytological research.

H. H. D.

PHYSICAL RESEARCH AT LEYDEN.

Het Natuurkundig Laboratorium der Ryks-Universiteit te Leiden in de Jaren 1882–1904. Gedenkboek aangeboden aan den Hoogleeraar H. Kamerlingh Onnes, Directeur van het Laboratorium, by gelegenheid van zyn 25-jarig Doctoraat op 10 Juli 1904. Pp. viii+288. (Leyden: Eduard Ydo, 1904.)

THIS volume was prepared by colleagues and pupils of Prof. Kamerlingh Onnes, of Leyden University, and presented to him on the twenty-fifth anniversary of his receiving the degree of Ph.D. It differs in character from the usual collections of scientific papers which it has become the fashion on the Continent to present to eminent men of science on